Density of Soils In-place by the Rubber Balloon Method

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1. Scope:

This test is for determining the density of soil in-place using a volumeter. This method is restricted to test hole volumes between 0.02500 and 0.05000 ft^3 and to bonded soil masses with a maximum particle size of ½".

2. Apparatus:

2.1 Volumeter conforming to the requirements of ASTM D2167.

NOTE: New volumeters shall be calibrated and volumeters which have had the jar and scale replaced or pressure gauge repaired or replaced shall be recalibrated, prior to use. Calibration shall be performed by the Region Materials Engineer. Jars and scales are not interchangeable. The serial numbers must be identical.

2.2 Digging tools: Chisel, hammer, scoop or spoon, prospector's pick.

2.3 Containers. Buckets with lids or plastic bags.

2.4 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.01 lb. and also one that is readable to the nearest 0.1 gram.

2.5 Drying equipment. An oven capable of maintaining a temperature of 230° ± 9°F or other equipment according to SD 108.

3. Procedure:

NOTE: References to base plate in this procedure apply only when the new type volumeters are being used.

3.1 Prepare the surface of the test area so that it is reasonably smooth and level (Free from loose material or holes). Place the volumeter and base plate on this surface and mark the outline of the base on the soil surface.

Take an initial reading using the same gauge pressure as was used during the calibration. Read the volume on the scale and record it on the worksheet.

3.2 Remove the volumeter from the test location and dig a hole centered within the scribed outline, or through the hole of the base plate. Exercise care so that soil around the top edge is not disturbed. Carefully place all the soil removed from the test hole in an airtight container for weight and moisture content determinations. Ensure the test hole volume is in accordance with SD 105, table 1.

3.3 Place the volumeter over the test hole or base plate in the same position used for the initial reading, and inflate the balloon in the hole. Using the same gauge pressure as was used for calibration, take and record the reading on the volume indicator. Release the pressure to deflate and retract the balloon from the hole. The difference between this reading and the initial reading is the test hole volume in $ft.^3$.

NOTE: The meter should be read to the nearest 0.00025.

3.4 Weigh the soil taken from the hole to the nearest 0.01 lb.

3.5 Mix the material thoroughly and select a representative sample for a moisture test, (SD 105, table 1). Weigh the material to the nearest 0.1 gram and dry it to a constant weight as per SD 108.

3.6 Standard Density Determination.

A. To determine standard density, take material from or adjacent to the test hole for SD 104, method 2 or method 4.

4. Report:

4.1 Calculations.

A. The procedure for calculating the in-place density, standard density, and moisture are shown on the DOT-41, figure 1.

The maximum dry density from the family of curves established by the 1-point determination is used to compute the percent of standard obtained for the test.

4.2 Report.

A. Report the moisture content to the nearest 0.1 percentage point.

B. Report the wet and dry densities for the in-place and standard tests to the nearest 0.1 $lb./ft^3$.

C. Report the percent of standard density to the nearest whole percentage point.

5. References:

ASTM D2167
SD 104
SD 105
SD 108
DOT-41

Sample ID 2205173
File No.

Density Report

DOT - 41
3-19

County: Aurora, Ziebach | PCN/PROJECT: B015 PH 0066(00)15
Station: 268+50 | Dist From CL: 17' R | Width (Gravel):
Depth: 0.5' (from top of Subgrade or Pipe) | Field #: E036
Tested By: Tester, One | Checked By: Tester, Two | Date: 04/27/2019

WORK AREA REPRESENTED (Circle what applies)

EMBANKMENT — STA. TO STA. 253+00 to 279+00 (per half mile, for each roadbed)
Zone 1 (0-1 ft.) | Zone 2 (1-3 ft.) | Zone 3 (3-5 ft.) | Zone 4 (5 ft. to bottom) 1 per 5 ft.

BRIDGE END EMBANKMENT — STA. TO STA.
1 per zone within plan limits | 3 equal zones when backwall is less than 7ft. | 4 equal zones when backwall is greater than 7ft.
Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5

BERM — STA. TO STA. (100 ft. from Bridge End)
Zone 1 (0-1 ft.) | Zone 2 (1-3 ft.) | Zone 3 (3-5 ft.) | Zone 4 (5 ft. to bottom) 1 per 3 ft.

PIPE	CROSS	24" or smaller	undercut	(1/2 way up)	(0-2 ft. Above)		
	STORM	30" to 72"	undercut	(Lower 1/2)	(Upper 1/2)	(0-2 ft. Above)	
	INTERSECTION	72" or more	undercut	(Bottom 1/3)	(Middle 1/3)	(Top 1/3)	(0-2 ft. Above)

After Minimum for size pipe installation ☐ 1 per 3 ft of backfill beginning at 2' above top of pipe

SUBBASE — STA. TO STA. — LIFT

BASE COURSE — STA. TO STA. — LIFT

Standard Density

Curve Type	Curve Used		Maximum Density	Optimum Moisure		Granular Material 4-Point Range
Ohio	O	U.	107.1	18.1	%	-

SPECIFICATION 95%
% Obtained 100X(G/U) 95%

Balloon Method

B. Wt. Undried Matl. from Hole	3.56
C. Volumeter Reading in Hole	0.04050
D. Initial Volumeter Reading	0.01025
E. Volume of Test Hole (C-D)	0.03025
F. Wet Density (B/E)	117.7
G. Dry Density F/(100+M) x 100	101.3

Sand Method

A. Std. Sand PCF		
B. Wt. Undried Matl. from Hole		
C. Initial Wt. Sand		
D. Final Wt. Sand Plus Cone Sand		
E. Volume of Test Hole (C-D)/A		
F. Wet Density (B/E)		
G. Dry Density F/(100+M)x100		

Nuclear Method

Meter No.
Test Mode
F. Wet Density from Gauge
+/-Corr. * =
G. Dry Density A/(100 + M-Field)x100

1-Point Density Determination

O. Weight of Mold & Specimen	13.32	
P. Weight of Mold	9.23	
Q. Wet Wt. of Molded Specimen (O-P)	4.09	
R. Factor of Mold No. 2-35 Used in Test	30.01	
S. Wet Density (QxR)	122.7	
T. Dry Density S/(100+M [1-PT])x100	105.6	

Moisture Determination

	1-Point	Field
H. Wt. of Wet Matl. and Container	130.7	109.1
I. Wt. of Dry Matl. and Container	112.5	93.9
J. Wt. of Moisture (H-I)	18.2	15.2
K. Wt. of Container		
L. Wt. of Dry Matl. (I-K)	112.5	93.9
M. Percent Moisture Field (Jx100)/L	16.2	16.2

Rock Determination

A. Total Sample Weight
B. Weight of Material Retained on 3/4" Sieve
C. Percent Retained On 3/4" Sieve (Bx100)/A

* Correction from DOT-39. If there is no correction or, if the correction has been applied to the meter show "NA".

Figure 1

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